Excerpts of Celestial Navigation

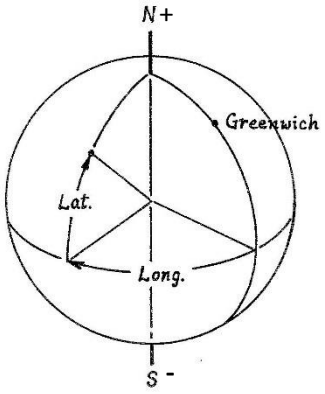
From: *Self-Contained Celestial Navigation H.O. 208* by John S. Lecther Jr and
Celestial Navigation with the S Table by Mike Pepperday

This information is not for those who believe that GPS will never fail and ancient methods of navigation should be abandoned. In Mr. Lectcher Jr's Chapter 18 "Navigation by Pocket Calculator," devices that came into being after the 1970's have basically replaced the reduction tables of H.O. 249, 214, 229, 208 and 211. Prior to pocket calculators "Bowditch the American Practical Navigator" had pages and pages of the Sine and Cosine to aid the navigator solving the basic sight reduction to arrive at the HC (height calculated) to compare against HO (Height Observed.)

The formula used being: Latitude of the observer (L) N+ or S-; declination of the star, sun or moon (D) N+ or S-; Local Hour Angle (t) measured from the observer to the observed body from East to West.

L=Latitude +N or –S; Latitude is the elevated pole of the observer
d=Declination +N or – S; Latitude of the body
t=LHA from you to body westward (Greenwich being 0^0 westward 360^0)

Figure 3-1 Page 16 Self Contained



The Formula:

$Hc = \sin^{-1}(\cos L \cos d \cos t + \sin L \sin d)$

$Z = \cos^{-1}[(\sin d - \sin L \sin h_c) \div (\cos L \cos h_c)]$

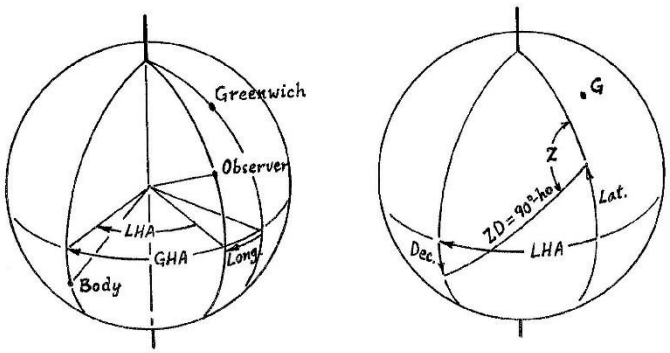
Azimuth = Z(+,-) from elevated pole = ZN

Longitude can be determined by:

$Long. = \pm COS^{-1}[(HO \sin - \sin L \sin d) \div (\cos L \cos d)]$

This formula actually solves for local hour angle and will render Longitude for any navigator who knows his exact Greenwich Time; thank you to Mr. John Harrison (3 April 1693 – 24 March 1776).

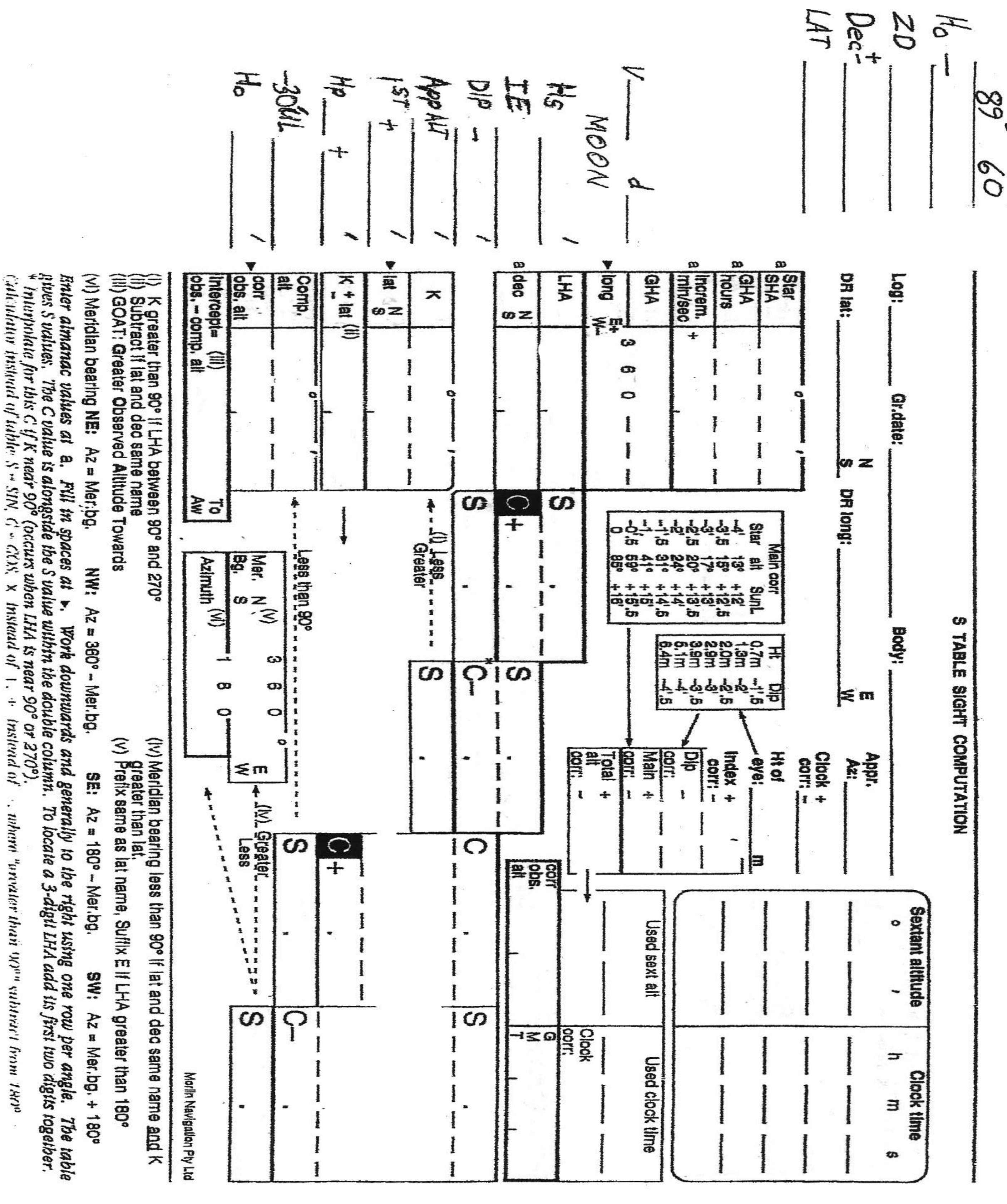
Fig 4-1 Page 21 (Self-Contained)



The geometric terms used in sight reduction: Local hour angle and azimuth.

H.O. 211 Published in 1931 has been upgraded and published as the S table on 9 total pages to an accuracy of 1′ of Arch. “The scientific calculator is a direct alternative to the S Table.” The S Table “transforms the clock time and sextant altitude into two numbers called azimuth and intercept.” The work sheet for the S Table is simple and concise. I have added the forms for Noon Sight solving for latitude and Lunar sight reduction Hs to H0 on the worksheet. The Nautical Almanac is the companion publication to the S Table and a very good chronometer with a known rate of error will take a sailor anywhere on the planet.

Tom Stokes



NOON
89° 60′
Ho –
ZD
Dec ±
LAT

V d
MOON
Hs
IE
DIP –
App ALT
1ST +
Hp +
–30′UL
Ho

S TABLE SIGHT COMPUTATION

Log: Gr.date: Body:

DR lat: N/S DR long: E/W

Appr. Az:

Clock + corr: –

Ht of eye: m

Index + corr: –

Dip corr: –

Main + corr: –

Total + alt corr: –

Sextant altitude ° ′ | Clock time h m s

Used sext alt | Used clock time

Clock corr:

corr obs. alt | GMT

Main corr		
Star	alt	Sun L.
–4′	13°	+12′
–3′.5	15°	+12′.5
–3′	17°	+13′
–2′.5	20°	+13′.5
–2′	24°	+14′
–1′.5	31°	+14′.5
–1′	41°	+15′
–0′.5	59°	+15′.5
0	85°	+16′

Ht	Dip
0.7m	–1′.5
1.3m	–2′
2.0m	–2′.5
2.9m	–3′
3.9m	–3′.5
5.1m	–4′
6.4m	–4′.5

a Star SHA
a GHA hours
a Increm. min/sec +
GHA
long E+ W– 3 6 0
LHA
a dec N S
K
lat N S
K ± lat (ii)
Comp. alt
corr obs. alt
Intercept= (iii) obs. – comp. alt To Aw

S C+ S C– S C S C+ S C– S

(i) Less Greater

Less than 90°

(iv) Greater Less

Mer. Bg. N S (v) 3 6 0 ° E W

Azimuth (vi) 1 8 0

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(i) K greater than 90° if LHA between 90° and 270°
(ii) Subtract if lat and dec same name
(iii) GOAT: Greater Observed Altitude Towards
(iv) Meridian bearing less than 90° if lat and dec same name and K greater than lat.
(v) Prefix same as lat name, Suffix E if LHA greater than 180°
(vi) Meridian bearing NE: Az = Mer.bg. NW: Az = 360° – Mer.bg. SE: Az = 180° – Mer.bg. SW: Az = Mer.bg. + 180°

Enter almanac values at a. Fill in spaces at ▸. Work downwards and generally to the right using one row per angle. The table gives S values. The C value is alongside the S value within the double column. To locate a 3-digit LHA add its first two digits together.
** Interpolate for this C if K near 90° (occurs when LHA is near 90° or 270°).*
Calculator instead of table: S = SIN, C = COS, x instead of ÷, + instead of –, where "greater than 90°" subtract from 180°